REMARKS

Summary of the Office Action

The Office Action indicates that the Examiner would like to obtain a copy of Umeda et al. that was cited in the Information Disclosure Statement filed on October 28, 2005 since the PCT Search Report indicates the claimed invention cannot be considered novel in view of this reference.

Claims 6 and 7 are objected to under 37 C.F.R. § 1.75(c) as being a substantial duplicate of claim 5.

Claims 1 and 3 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over U.S. Patent No. 5,176,760 to Young ("Young"), Japanese Patent No. 03-006362 ("JP '362") or Japanese Patent No. 04-168273 ("JP '273").

The Examiner has indicated that claims 6 and 7 would be allowable if Applicants cancel claim 5 to overcome the duplicate claim objection.

Summary of the Response to the Office Action

Claims 1, 3, and 5 are presently pending. Claims 6 and 7 are cancelled.

Applicants thank the Examiner for indicating that claims 6 and 7 would be allowable if Applicants cancel claims 5 to overcome the duplicate claim objection.

Information Disclosure Statement

The Office Action indicates that the Examiner would like to obtain a copy of Umeda et al. that was cited in the Information Disclosure Statement filed on October 28, 2005 since the PCT Search Report indicates the claimed invention cannot be considered novel in view of this reference.

While the undersigned's records indicate that a copy of Umeda et al. was submitted with the Information Disclosure Statement filed on October 28, 2005, a copy of the reference is included with this Response for the Examiner's convenience.

Objection under 37 C.F.R. § 175(c)

Claims 6 and 7 are objected to under 37 C.F.R. § 1.75(c) as being a substantial duplicate of claim 5. Claims 6 and 7 have been cancelled to overcome the objection.

Rejections under 35 U.S.C. § 103(a)

Claims 1 and 3 stand rejected under 35 U.S.C. § 103(a) as being unpatentable over Young, JP '362, or JP '273. Applicants respectfully traverse the rejection.

All three cited references are based on the use of ordinary stainless steels according to the Japanese Industrial Standard (JIS). In contrast, the present invention is based on the use of ultrahigh purity stainless steels such as those developed by Daido Steel Co., Ltd. to satisfy the special requirements of the semiconductor industry and having a far higher purity than the ordinary stainless steels according to the JIS.

The Daido steels are known under the trademarks "Clean Star A and B" and have the following characteristics:

- They are manufactured by using a vacuum melting furnace to expel impurities and have an impurity content that is far lower than that of the ordinary stainless steels according to the JIS. Although Table 1 in the specification shows the composition of Clean Star alone, the pamphlet of the company, which is attached herewith together with the partial English translation thereof, also contains the composition of ordinary stainless steel (SUS 316L).
- Their chromium content of 10% or more satisfies the requirements of the JIS for stainless steels.
- In order to achieve a higher corrosion resistance, they have a nickel content that is higher than that of austenitic stainless steel SUS 316L according to the JIS.

The JIS requires that low carbon stainless steels such as SUS 304L and SUS 630L have a carbon content of 0.03% or less. Because ordinary stainless steels and low carbon stainless steels are separately defined according to the JIS, it is apparent that the carbon content of ordinary stainless steels such as SUS 304 and SUS 630 is 0.03% or higher. In contrast, claim 1 recites a carbon content of less than 0.01% or less.

The present invention imparts sealing performance to stainless steel so that it can be used as a sealing member. The qualities imparted are wear resistance, flexibility, and separability, qualities for which low carbon content in stainless steel is crucial. The performance of the stainless steel according to the present invention is exhibited by its flexibility as ultralow carbon stainless steel.

The three cited references are based on the use of ordinary stainless steels according to the JIS and differ from the present invention, as explained below. Moreover, Young also discloses a manufacturing process different from that employed by the present invention, as discussed below.

- JP '273: The metal disclosed in this reference is supposed to be applied to seawater resistant spindles for seawater pumps and screw bearings for vessels including bearing journals and impeller casings, and is based on the use of stainless steels which are higher in strength than austenitic stainless steel SUS 304, as shown in the Examples. Therefore, a carbon content of at least 0.08% is required according to the standard. http://www.silicolloy.co.jp/sus304.html (The standard is JIS.)

- JP '362: This reference discloses ion implantation not intended for any specific industrial use, but based on the use of ordinary stainless steels. It employs SUS 304 in Example 1 and SUS 440 C in Examples 2-4, as well as in Comparative Examples 3 and 4. SUS 304 has a carbon content not higher than 0.08% according to the standard. http://silicolloy.co.jp/sus440c.html

- Young: The metal disclosed in this reference is supposed to be applied to seals on aircraft engines, requires stainless steels of high strength, and employs stainless steel for high-strength springs, A-286 in the Examples. The Examples also show the use of precipitation-hardened stainless steel, 17-4 PH.

  The carbon content of the high strength heat-resistant stainless steel (INCOLOY), A-286, is specified by JIS: 5525-6.5731-2.5734.5737.5858.6895 (JIS G 4311). The precipitation-hardened stainless steel, 17-4 PH (equivalent to SUS 630), has a carbon content not higher than 0.07%. http://www.silicolloy.co.jp/sus630.html

Young discloses a process in which nitrogen ions are injected into stainless steel by employing a discharge voltage of 400 to 600 V in a first stage and a discharge voltage of 1.5 to 2 kV in a second stage. The injection of ions employing a discharge voltage has so low a level of energy that the greater part of the injected ions stop in the metal surface (within one or two atom layers) in the first stage and within several atom layers even in the second stage. The ions injected reach a depth of 250 to 760 nm below the steel surface by thermal diffusion into the interior of the stainless steel.

There is no data in Young about the degree of hardness or abrasion resistance, while the present invention demonstrates significant changes in hardness of the surface layer (A factor of 5.6 difference between the surface layer and the remainder of the metal in the Example on page 20 at lines 16-19.) and abrasion (Only 4% of that of SUS 316L as shown in Table 4.).

With the present invention, the thickness of the surface layer is thin, with the peak of hardness at a depth of 40 nm and the half-width of the hardness being 110 nm or less. (page 20, lines 19-22.) This results in greatly improved wear resistance, adhesiveness, and flexibility. The sealing function of the present invention is achieved by adhesiveness rather than surface smoothness. This results in a very durable pipe joint. Even if the surface is damaged such as by a scratch, flexible deformation assists in the sealing function.

In contrast, the ions injected in Young reach a depth of 250 to 760 nm below the steel surface by thermal diffusion into the interior of the stainless steel. As a result, the wear resistance is speculated to only twice as good as that of SUS 316L. The relatively high carbon content of the stainless steel of Young results in a hardened surface layer. As a result, the adhesiveness and flexibility of Young are poor, with the sealing function only exhibited by the smoothness of the product. The decrease in the sealing function due to a scratch cannot be prevented.

In summary, ion implantation according to the present invention is far superior to the process of Young, which relies on discharge and thermal diffusion (The process of Young is not ion implantation, but ion bombardment.), even when they are compared with respect to wear resistance alone.

Applicants believe that claims 1, 3, and 5-7 are in condition for allowance. Allowance of claims 1, 3, and 5-7 is requested.

CONCLUSION

In view of the foregoing, Applicants respectfully request reconsideration and the timely allowance of the pending claims. Should the Examiner feel that there are any issues outstanding after consideration of this response, the Examiner is invited to contact Applicants' undersigned representative to expedite prosecution.

If there are any other fees due in connection with the filing of this response, please charge the fees to our Deposit Account No. 50-0310. If a fee is required for an extension of time under 37 C.F.R. § 1.136 not accounted for above, such an extension is requested and the fee should also be charged to our Deposit Account.

Respectfully submitted,

MORGAN, LEWIS & BOCKIUS LLP

Dated: September 19, 2008

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Kent Basson
Registration No. 48,125

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(1)

クリーンスター

大同の
ステンレス鋼

DAIDO STEEL

情報社会を加速する大同のクリーンスター 超清浄
(2)

(3) 大同のクリーンスターは、当社独自の優れた溶解鋳造技術により、鋼中の非金属介在物やガス成分を著しく低減した、清浄度の高いステンレス鋼です。
極高真空装置部品や半導体製造装置に使用され、エレクトロニクス分野の先端技術に貢献しています。

[1] EAVACプロセス

Electric Arc Furnace	電気孤光炉
AOD Equipment	アルゴン酸素脱炭装置
VAcuum Degassing	真空脱ガス
Continuous Casting	連続鋳造

当社のAODでは、真空処理を行いながら大きな撹拌力が得られる**VCR**(Vacuum Converter Refiner)法の適用により、極低C、Nのステンレス鋼を溶解することができます。

[2] 特殊再溶解

VAR(真空アーク再溶解)…………高真空中での再溶解が可能であり、ガス成分を著しく低減できます。

ESR(エレクトロスラグ再溶解)……低抵抗フラックス使用により、非金属介在物を少なくし微細にできます。

(4)
■大同クリーンスター 化学成分(mass%)の実績

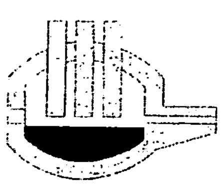
元素 -(5)	C	Si
JIS G4303 SUS316L	≦ 0.030	≦ 1.00
材料名称 -(6)		
クリーンスターA -(7)	0.006	0.13
クリーンスターB -(8)	0.007	0.23
クリーンスターC -(9)	0.012	0.51
SUS316L一般品 -(10)	0.013	0.52

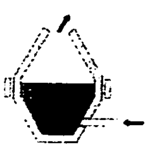
■非金属介在物測定結果 -(11)

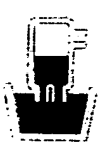
介在物測定法 -(12)	JIS法(Total)
材料名称 -(13)	0.02 0.04 0.06 0.08 (%)
クリーンスターA (14)	
クリーンスターB (15)	
クリーンスターC (16)	
SUS316L一般品 (17)	

クリーンスターの製造工程 -(18)

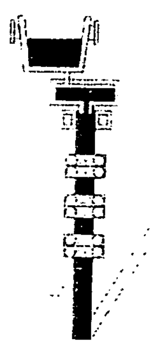
溶解・精錬 -(19)


アーク炉 ~(20)


AOD


RH脱ガス -(21)

鋳造 -(22)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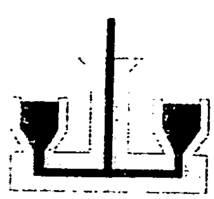
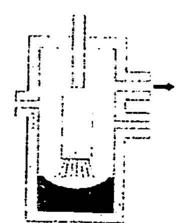
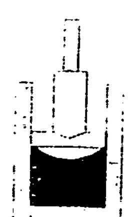

造塊 -(24)

特殊再溶解 -(25)

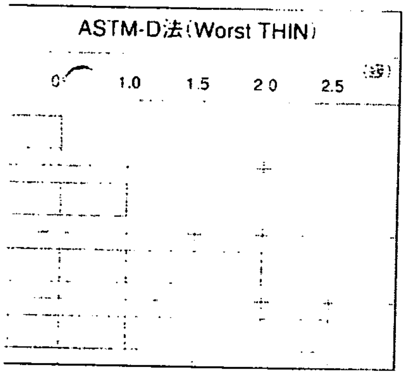

VAR炉 -(26)


ESR炉 -(27)

代表例

＊指定：ppm

Mn	P	S	Cu	Ni	Cr	Mo	Aℓ	N＊	O＊	H＊
≦ 2.00	≦ 0.045	≦ 0.030	—	12.00 ～ 15.00	16.00 ～ 18.00	2.00 ～ 3.00	—	—	—	—
0.04	0.020	0.001	0.17	14.64	16.95	2.25	＜0.002	65	5	1.6
0.23	0.025	0.001	0.19	14.66	16.91	2.23	0.002	80	7	2.0
0.43	0.026	0.004	0.20	12.15	16.85	2.03	0.002	160	49	3.0
1.84	0.030	0.007	0.33	12.11	16.83	2.02	0.002	270	62	3.0



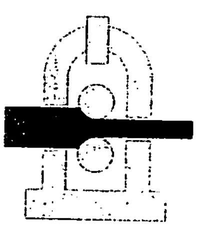
■腐食試験結果

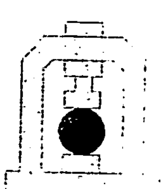
単位：g/m²·h

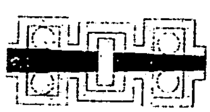
腐食試験法 / 材料名称	全面腐食 1% HCℓ 室温 6hr	全面腐食 5% H_2SO_4 室温 6hr	孔食 6% $FeCℓ_2$ 35℃ 24hr	粒界腐食 Strauss 硫酸一硫酸銅
クリーンスターA	0.02	0.02	1.47	0.15
クリーンスターB	0.04	0.04	2.21	0.16
クリーンスターC	0.23	0.06	10.49	0.20
SUS316L一般品	0.25	0.07	11.61	0.21
	JIS G0591	JIS G0591	JIS G0578	JIS G0578

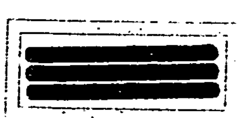
※表中のJIS規格No.は参考規格

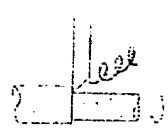
分　塊　-(28)　　仕上圧延・熱処理 (31)　　加工・酸洗 (34)　　製　品 -(38)

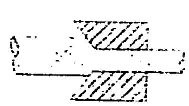

圧延 -(29)

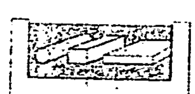

鍛造 -(30)

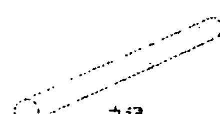

製品圧延 -(32)

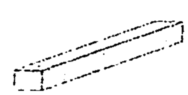

熱処理 -(33)


ピーリング加工
ターニング加工 (35)


コンバインド加工 (36)


酸洗 (37)


丸鋼 -(39)


角鋼 -(40)


平鋼 -(41)

Partial English translation of pamphlet of Clean Star

(1) Clean Star

(2) Daido Clean Star Ultra-Clean Stainless Steels

Accelerating the Progress of the Information Society

- For the Coming Generation of Electronic Technology –

(3) Daido Clean Stars are stainless steels of high purity having a drastically lower content of nonmetallic inclusions and gases achieved by the original and outstanding melting and casting technologies of the company.

They are used for making the parts of ultrahigh vacuum apparatus and apparatus for manufacturing semiconductors, and contribute to the most modern technology in electronics.

[1] EAVAC Process

Electric arc furnace

AOD equipment

VAcuum degassing

Continuous casting

The company's AOD enables the manufacture of stainless steels having very low carbon and nitrogen contents by employing the VCR (vacuum converter refiner) process allowing a large stirring force during vacuum processing.

[2] Special Remelting

VAR (vacuum arc remelting) – Remelting in a high vacuum enables a drastic reduction of gases.

ESR (electroslag remelting) – The use of a flux of low resistance enables a reduction of non-metallic inclusions and a fine division thereof.

(4) *Daido Clean Star – Typical examples of chemical analysis (mass %)

(5) Element

(6) Designation of material

(7) Clean Star A

(8) Clean Star B

(9) Clean Star C

(10) Ordinary SUS 316 L

(11) *Results of measurements of non-metallic inclusions

(12) Method of measurement / JIS method (Total) / ASTM-D method (Worst THIN)

(13) Designation of material

(14) Clean Star A

(15) Clean Star B

(16) Clean Star C

(17) Ordinary SUS 316 L

(18) *Process for Manufacturing Clean Stars

(19) Melting and refining

(20) Arc furnace

(21) RH degassing

(22) Casting

(23) Continuous casting

(24) Ingot making

(25) Special remelting

(26) VAR furnace

(27) ESR furnace

(28) Billet making

(29) Rolling

(30) Forging

(31) Finish rolling and heat treatment

(32) Final rolling

(33) Heat treatment

(34) Working and pickling

(35) Peeling and turning

(36) Combined working

(37) Pickling

(38) Product

(39) Round bar

(40) Square bar

(41) Flat bar

Various properties of SUS304 (austenitic stainless steel)

【File No.SUS304-001】

SUS304の諸特性(オーステナイト系ステンレス)

1. はじめに

SUS304はオーステナイト系ステンレスの代表的な鋼種で、耐食性、靭性、延性、加工性、溶接性に優れ、幅広い用途で使用されています。

クロムニッケル系ステンレス鋼で主成分は18%Cr-8%Ni、金属組織は耐食性に優れるオーステナイトを呈しています。

2. 化学成分 (Chemical composition)

component

(wt%)

成分	C	Si	Mn	P	S	Ni	Cr	Fe
規格	≦0.08	≦1.00	≦2.00	Max 0.045	Max 0.030	8.00-10.50	18.00-20.00	Bal.
成績例	0.50	0.38	1.08	0.035	0.025	8.17	18.50	

Data No.SUS304-MS-20070525001

＊化学成分は一例です

standard

example of score

3. 物理的性質

熱処理状態	密度 (g/cm^2)	比熱 (cal/g℃)	比電気抵抗 (μΩ·cm)	線熱膨張係数 ×10^{-6}/℃	熱伝導率 (W/mK)	縦弾性係数 (GPa)
		0～100℃	20℃	0～100℃	100℃	
固溶化熱処理	8.03	0.12	72	17.3	16.3	193

Data No.SUS304-TR-2007062201

4. 機械的性質

4. 1 機械的性質の規格

	熱処理	引張強度 (N/mm^2)	耐力 (N/mm^2)	伸び (%)	絞り (%)	硬度 (HB)
規格	固溶化熱処理	520以上	206以上	40以上	60以上	187以下 (HRC10以下)

Data No.SUS304-TR-2007062202

4. 2 機械的性質の一例

	熱処理	引張強度 (N/mm^2)	耐力 (N/mm^2)	伸び (%)	絞り (%)	硬度 (HB)
規格	固溶化熱処理:1010-1150℃急冷	520以上	206以上	40以上	60以上	Max187 (HRC10)
一例	固溶化熱処理:1050℃水冷	635	285	58	75	160 (HRC3)

Data No.SUS304-TR-2007062203

＊機械的性質は一例です

5. 顕微鏡組織

Various properties of SUS440C
(martensite stainless steel)

【File No.SUS440-001】

SUS440Cの諸特性(マルテンサイト系ステンレス)

1. はじめに

SUS440Cマルテンサイト系ステンレスで、熱処理(焼入・焼もどし)により、高強度、高硬度を得られます。
ステンレス鋼の中では最も高硬度を有する鋼です。
耐食性は一般の焼入鋼よりは優秀ですが、オーステナイト系ステンレス、フェライト系ステンレスおよび析出硬化系ステンレスよりは炭素(C)含有量が高いため劣ります。

2. 化学成分 (Chemical composition)

component

(wt%)

成分	C	Si	Mn	P	S	Ni	Cr	Mo	Fe
規格	0.95–1.20	≦1.00	≦1.00	Max 0.040	Max 0.030	≦0.60	16.00–18.00	≦0.75	Bal.
成績例	1.04	0.25	0.31	0.021	0.001	–	16.28	–	

Data No.SUS440-MS-2006091001

＊化学成分は一例です

Standard
example of score

3. 物理的性質

熱処理状態	密度 (g/cm²)	比熱 (cal/g℃)	比電気抵抗 (μΩcm)	線熱膨張係数 ×10⁻⁶/℃		熱伝導率 (W/mK)	縦弾性係数 (GPa)
		0〜100℃	20℃	0〜100℃	0〜540℃	100℃	
焼なまし状態	7.78	0.11	64	10.2	11.7	24.3	204

Data No.SUS440-TR-2006091001

4. 機械的性質

4.1 機械的性質の規格

	熱処理	引張強度 (N/mm²)	耐力 (N/mm²)	伸び (%)	硬度 (HB)
規格	焼なまし	540以上	225以上	18以上	235以下 (HRC22)

Data No.SUS440-TR-2006091001

4.2 機械的性質の一例

	熱処理	引張強度 (N/mm²)	耐力 (N/mm²)	伸び (%)	絞り (%)	硬度 (HRC)
規格	焼入:1010–1070℃油冷 焼もどし: 100–180℃空冷	–	–	–	–	58以上
一例	焼入:1060℃ 焼もどし:180℃/AC	–	–	–	–	60

Data No.SUS440-TR-2006091001

＊機械的性質は一例です

4.3 焼入れ硬さ

焼入温度	900℃	950℃	1000℃	1050℃	1150℃
硬度(HRC)	47	53	59	61	42

Data No.SLA-001-T0002

4.4 焼もどし硬さ

Various properties of SUS630
(precipitation hardened stainless steel)

【File No.SUS630-001】

SUS630の諸特性(析出硬化系ステンレス)

1. はじめに

析出硬化系ステンレスの代表鋼で、耐食性と高強度を兼ね備えています。
SUS630は1020～1060℃の固溶化熱処理(溶体化熱処理)後に、析出硬化熱処理(時効硬化熱処理)を施し、Cu-rich相を析出させることで、高強度と高硬度を得られます。硬度を重視するH900(470～490℃/AC)から靭性を重視するH1150(610～630℃/AC まで4段階の熱処理が規定されています。

2. 化学成分 Chemical composition

component

(wt %)

成 分	C	Si	Mn	P	S	Cu	Ni	Cr	Nb+Ta	Fe
規格	≦0.07	≦1.00	≦1.00	Max 0.040	Max 0.030	3.00–5.00	3.00–5.00	15.50–17.50	0.15–0.450	Bal.
成績例	0.05	0.25	0.89	0.035	0.006	3.33	4.25	15.59	0.37	

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standard
example of score

＊化学成分は一例です

3. 物理的性質

熱処理状態	密度 (g/cm^2)	透磁率 (常温)		比熱 (cal/g℃)	線熱膨張係数 $\times10^{-6}$/℃				熱伝導率 (W/mK)		
		100Oe	200Oe	0～100℃	20～100℃	20～200℃	20～300℃	20～400℃	150℃	250℃	450℃
固溶化熱処理	7.78	74	48	0.11	10.8	10.8	11.1	11.3	–	–	–
H900	7.80	90	56	0.11	10.8	10.9	11.3	11.7	17.6	19.3	22.2
H1075	7.81	88	52	–	11.3	11.7	11.9	12.2	–	–	–
H1150	7.82	59	88	–	11.9	12.4	12.8	12.9	–	–	–

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4. 縦弾性係数(ヤング率)

熱処理状態	ポアソン比	縦弾性係数 (GPa)		
		0℃	50℃	100℃
固溶化熱処理	–	197	197	194
H900	0.272	208	205	203
H1075	0.272	–	–	–
H1150	0.272	–	–	–

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5. 機械的性質

5. 1 熱処理規格

種類	熱処理記号	熱処理	引張強度 (N/mm^2)	耐力 (N/mm^2)	伸び (%)	硬度 (HRC)
固溶化熱処理	S	1020～1060℃急冷				38以下
析出硬化熱処理	H900	S処理後 470～490℃空冷	1310以上	1175以上	10以上	40以上
	H1025	S処理後 540～560℃空冷	1070以上	1000以上	12以上	35以上